The CORNELL ENGINEER

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THE NEW ENGINEERING COLLEGE COUNCIL

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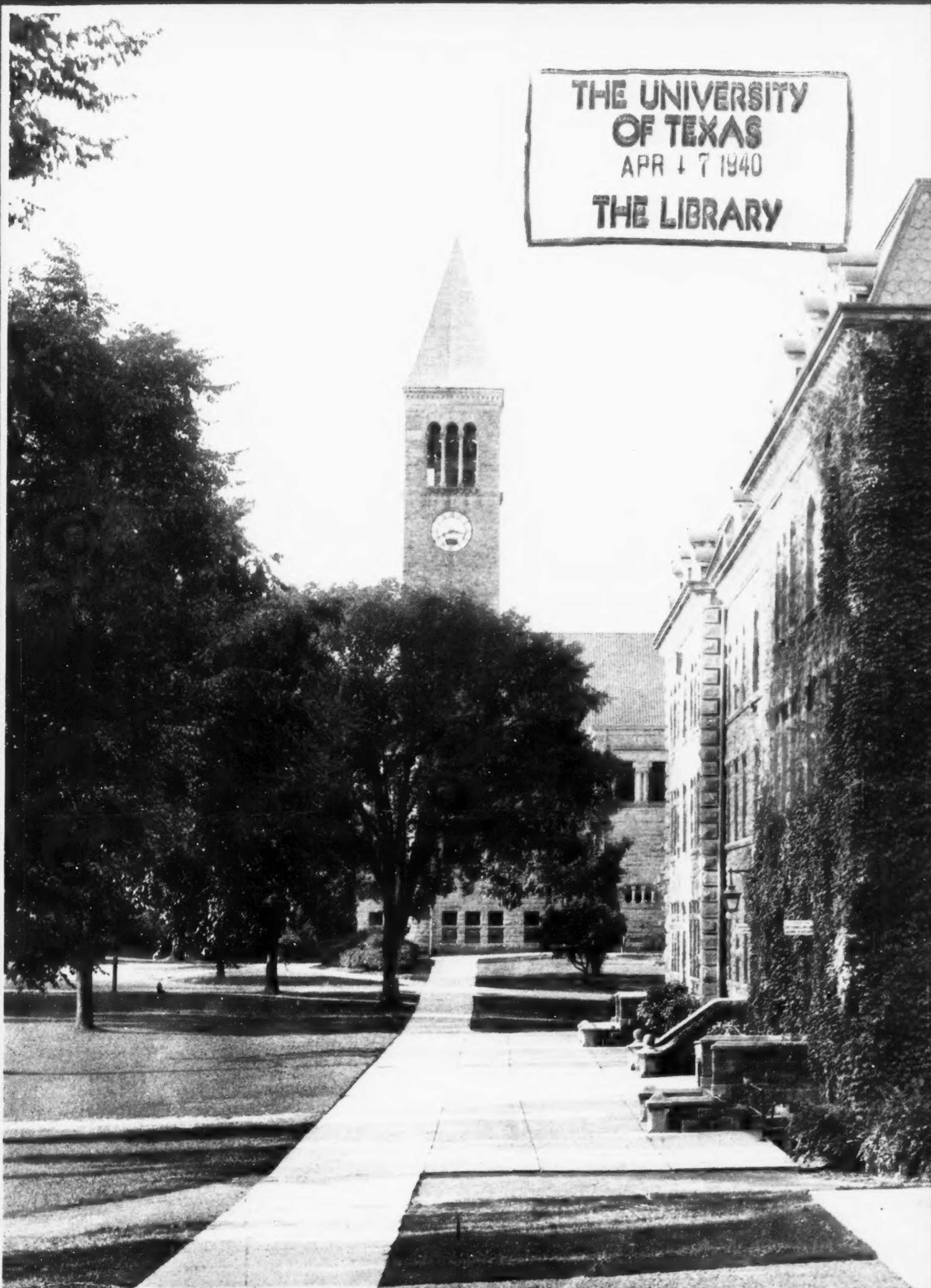

The CORNELL ENGINEER

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AUTHORS

Tell Berna, M.E. '12, is a familiar figure at Cornell. Seniors will recall him as a frequent lecturer on the general subject of industrial economics, and as general manager of the National Machine Tool Builders Association. He is indeed a well qualified speaker.

Mr. Berna should also need no introduction to the alumni. During his undergraduate career he made his place as one of Cornell's track immortals by setting several track records, and in addition was generally very active on the campus.

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FRONTIS

The Frontis and the illustrations in the Machine Tool article are typical defensive weapons dependent upon machine tools.

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COVER

Spring on the campus.

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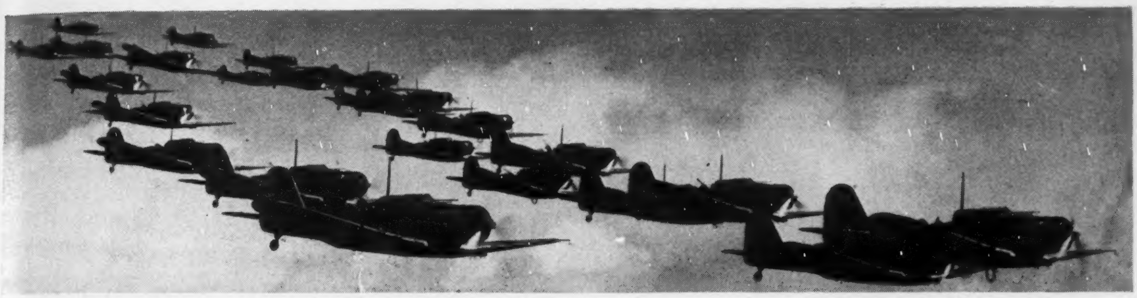
—*Courtesy of Army Ordnance*

ANTI-AIRCRAFT GUN



—*Courtesy of Aero Digest*

Machine Tools and the Emergency

By TELL BERNA, M.E. '12

Within the last decade in every phase of human endeavor mechanization has made enormous strides. This is just as true with respect to armies as it is with respect to peacetime endeavors. For that reason machine tools have become an important element in the international situation—because machine tools represent, to a large extent, the basic ways and means whereby mechanization is made possible. The development of airplanes and tanks as instruments of war to be used upon a mass scale has necessitated an enormous increase in the number of metal-working machines of all kinds used in the manufacture of these devices. Similarly the development of automatic rifles and of anti-tank and anti-aircraft rapid-fire guns which increase consumption of ammunition and shell, calls for large numbers of machine tools, both for the manufacture of the guns themselves and for the manufacture of shell and ammunition.

It is, therefore, timely to consider the American machine-tool industry—its ability to meet the requirements of the present situation and the far more serious outlook that might result if this nation were actually to become involved in war.

The machine-tool industry is not a large industry. It employs from 40,000 to 60,000 men. It is not an industry that can be easily expanded with rapidity, for various reasons. One reason is that machine tools require a large investment in machine tools, for their own manufacture. Therefore, expansion means a substantial capital investment in equipment.

Another reason is the nature of the skill and experience required in machine tool manufacture. Machine tools which perform in accordance with modern requirements—capable of making parts as accurately as they must be made today for gun recoil mechanisms and airplane engines—must work to tolerances of two, or even one tenth of a thousandth of an inch. This sort of accuracy requires highly skilled men. While it is possible to train some men rapidly to do certain types of work, the broad plant experience required of the majority of the workmen in a machine-tool plant simply cannot be acquired in a hurry.

Nevertheless in spite of these facts the industry, like many other durable goods industries, is subject to extreme variation in demand. In good times this demand comes normally from an amazingly wide variety of sources, many of which we would not at first thought associate with metal-working tools.

For instance—increased demand for clothes must be met by making textile machinery and sewing machines—and this requires machine tools. Increased building means the manufacture of more domestic appliances—and these appliances are built largely on machine tools. The farmer plows, plants, cultivates and harvests his crops with equipment produced chiefly on machine tools and his products are shipped to market by truck and by freight car—which are likewise made largely by machine tools.

The fact is that there is hardly a device known to civilized man today, which is not made on or by machine tools or by machinery which in turn has been made by machine tools. Therefore when all of the country's industries are busy, the demand on the machine-tool industry is naturally multiplied many fold.

When business in general starts to fall off, the reverse promptly takes place. The factory manager

—*Courtesy of Army Ordnance*

conserves his cash in order to weather the storm. Instead of buying new machine tools, he uses whatever equipment he has on hand. He postpones the purchase of better equipment until the business trend is again unmistakably reversed and he feels sure that the upward trend will continue for some time.

Now during such adverse periods, the machine tool builder must contrive somehow to carry over from the last good period until the next good period. He keeps a nucleus of his best men at work—for he dares not lose the special skills which they have acquired. Meanwhile he draws on his cash reserve to pay for research, experiment and design—so that as business improves and his market slowly recovers, this market may be stimulated by the introduction of new, more accurate and more productive machine tools.

The results of research and experiment during lean periods are evident during each period of recovery. The last few years afford a typical illustration. During this period we have seen a great improvement in every sector of the machine tool industry. Machines are more rigid and afford better support to the cutting tool. Lubrication is more nearly automatic, moving parts are more effectively guarded. The use of alloys for almost every part of the machine adds to its life and the maintenance of accuracy. The choice of feeds and speeds available has been greatly increased, so that carbide tools can be economically used in a wider range of work. The outline of the machine has been simplified. Electrical equipment until recently applied externally has been designed as a part of the machine and built into it. Control is simpler and more convenient.

These things have been done not to add features which salesmen can praise, but to increase productivity of machine tools and make possible greater accuracy, better finish and finer quality.

Meanwhile the machine tool operator has achieved a function quite different from the part he played not so many years ago. In the old days he was a source of power. Today, power is built into the machine—and the operator guides that power. In the old days, the operator was expected to possess a manual skill sufficient to obtain accuracy in spite of the shortcomings or deficiencies of the machine tools which he operated. Today, that type of skill is likewise built into the machine itself—and the sort of skill required of the operator today consists of knowledge and understanding of the ways and means whereby the machine tool on which he works will be capable of the greatest degree of productivity and the maximum extent of performance.

In short, by machine tools workmen today not only make various parts of almost all of the machines and contrivances which go into our civilization—but make these parts more rapidly and more accurately. And by making possible a larger production per man-hour employed, they make possible higher wages, or shorter hours, or lower prices to the consumer—or all three of these desirable aims.

Better quality and lower prices widen the market and quicken demand. This, in turn, makes for increased employment. Of course such increases are not always immediately apparent. Here and there labor is sometimes displaced and the process of adjustment is difficult. But in the long run, machine tools, by increasing the productivity of mankind, have made possible the employment of millions of workers who otherwise would never have been employed in making the products which they today turn out by the thousands.

The radio, vacuum cleaner, electric refrigerator, airplane, and many other industries—I mention particularly new industries which literally did not exist a few years ago—could never have gotten out of the experimental stage had it not been for machine tools, which made possible production on a basis of minimum costs, and thereby brought the product within reach of the buyers' pocketbooks. No one has ever found a better way to improve the living standards of a nation.

The consistent improvement in machine tools which

is particularly apparent, as above noted, during each period of recovery develops naturally from free competition and individual initiative. There is not only competition between companies building a certain type of machine tool but also between companies advocating different methods of machining for a certain job. There, as in all American industry, competition is the very lifeblood of progress. This brings us to the particular situation confronting the machine tool industry today—which, frankly, can only be described as an emergency.

The industry came out of the last great depression with sadly depleted financial reserves, but with a large number of remarkable new developments, spurred on by competition and by the desire to regain markets. Their effect upon manufacturing procedures proved to be well-nigh revolutionary.

Particularly is this true with respect to accuracy. It is hard to say, for instance, whether aircraft needs stimulated machine tool accuracy, or machine tool accuracy stimulated aircraft production—but the fact is that the building of today's aircraft would be absolutely impossible were it not for the increased accuracy which has been built into the machine tools developed since the end of the 1929-33 depression.

As business continued to emerge from the depression, machine-tool buying from all sorts of manufacturing fields naturally increased. And then suddenly, last Fall, came the European war. With that war came an unprecedented demand for certain devices and equipment, particularly aircraft, needed in modern warfare; and an unprecedented demand for the machine tools required for the manufacture of such devices.

This situation was by no means confined to the machine tool needs of foreign powers who were already engaged, or feared they might become engaged in the war. It was inevitably tied directly into the national defense picture of the United States. This situation has suddenly placed upon the machine tool industry a demand out of all proportion to past experience. The industry has taken strenuous measures to meet this demand. For instance, during the six months' period from June to December, 1939, the output of machine tools was doubled; and output still continues to increase.

The picture is especially complicated due to the fact that the new demand for machine tools arising from the background of war abroad and national defense at home has coincided with the largest demand for machine tools for normal peacetime manufacturing purposes that has been experienced in this country for years.

The nation's machine tool builders would far rather send new equipment to the normal peacetime factories of this country than ship it abroad. They know that a large share of the manufacturing equipment of the United States became obsolete during the depression years, and is sadly in need of renewal. They know that new and better equipment in the plants of this country means lower costs, lower prices, greater volume and larger employment. They are convinced that the efficient re-equipment of the industrial plants of this country represents the strongest assurance we can possibly have that our national recovery is really under way, and that we are once more back again on the road toward prosperity and security for the nation.

But meanwhile—and it is a matter of immediate concern—the industry finds itself in an exceptional, and possibly temporary, situation——arising from the European war and national defense repercussions at home. In facing this dilemma, the industry merely

(*Continued on page* 23)

—Courtesy of Army Ordnance

X-Ray and the Engineer

By L. E. BUSSEY, '43

The year is 1895, the city of Wurzburg, in northwest Bavaria, has awakened to a cold December morning, and over their morning *kaffee* the city folk are glancing through this morning's *Zeitung*. Over here on the third page is a modest announcement concerning the discovery of a weird form of radiation in the physics laboratories of the nearby University. The professor physics there, Wilhlem Konrad Roentgen, has been experimenting with electric discharges in evacuated tubes recently, and he has accidently noticed the strange effects of a renegade discharge on a fluorescent screen behind a piece of black paper. Because of their queer behavior "he has given this radiation the name of 'X-rays' . . ."

From this humble beginning, the accidental discovery of what is now a useful and interesting tool, has sprung a great industry. Great scientific minds have applied themselves to the development of the X-ray—Roentgen himself discovered that the radiation would affect fluorescent screens and it was a simple step to use photographic plates that would afford permanence to the record that the X-rays left. Furthermore, the results of pioneer experiments showed that X-rays are unaffected by mirrors, lenses, prisms, magnetic fields, or any other agency or body introduced into their presence during the course of natural experimentation. And, in 1913, Max von Laue discovered that a crystal would diffract X-rays much the same as a grating diffracts visible light rays—developed and refined today into an accurate technique for the determination of wave-lengths, which the metallurgist finds applicable in metals analysis. Thus has industry learned to use Roentgen's discovery as a means for examining the interior of products without cutting them open, for inspecting welds and seams, for proper fabrication of non-metallic objects, for analysis of materials, and for countless other applications in production. The metals industry finds the X-ray a particular aid in diffraction for the determination of analysis and for crystal study, and in radiographic photography for the detection of defects.

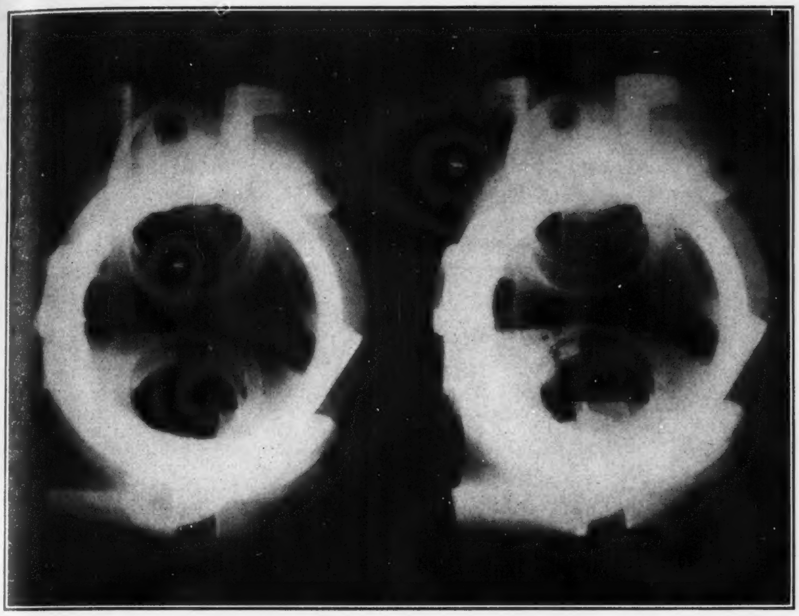
In Castings

Since the first mold was constructed, foundrymen have been confounded by shrinkage, cracks, piping, blowholes, dendritic formations—these imperfections being the more familiar among many. Superintendents of foundries know how often these defects in castings will occur despite their best efforts to coordinate the numerous "foundry variables": the properties of the sand, the location of gates and risers, the shape and thickness of sections, the construction of the mold, the pouring temperature, and the composition of the pour. Heretofore the accepted practice to determine the results of foundry practice has been to section the casting—cutting "slices"—to determine the interior appearance. This method is not only expensive to the manufacturer, but inaccurate as well, inasmuch as only *part* of a casting may be examined with one sectioning operation. It is easily seen that a great number of cuts are needed for an accurate determination of correctness of foundry procedure, and it is much more easily seen that a consequently higher cost of fabrication is made manifest with each additional cut.

Another factor non-homogeneity, must also be considered in sectioning. It is reasonable to suppose that a casting is not physically and chemically homogeneous throughout, and this supposition has been borne out by experimentation. Since the presence of heterogeneous conditions is often undesirable and unacceptable in castings, their detection was somewhat a problem both in method and expense, and the casting industry searched for a more thorough and economical means for remedying foundry practice in order to produce better castings. They turned to the X-ray as a medium of internal inspection for the perfection of foundry procedure, and for the routine production-line inspection after a satisfactory procedure had been established, finding the non-destructive radiographic examination of specimen castings to be superior to the former methods of sectioning.

In certain installations the principle use of the X-ray is the perfecting of foundry practice; in other installations it is to supplement sectioning operations, with an increased saving where great accuracy is not a factor; and in still others, as in the U. S. Government Arsenals at Watertown and Rock Island, the principle is entirely that of inspection.

In development of foundry practice great progress has been made in the last ten years as a result of the complete or partial use of the X-ray. Beginning with large, unwieldly, permanent X-ray assemblies installed in the middle and late 1920's, metallurgists rapidly



—Courtesy of American Society Testing Materials

Fig. 1—Defects in Aluminum Alloy Cylinder Heads

gathered information about the effects of foundry variables, and today with their modern, mobile units they are in a position to perfect any given foundry practice in a minimum of time with a minimum of expense. Since the production of a commercially sound casting rests entirely with the foundry, great responsibility is placed upon the method used. It is the foundry's reliability which is at stake, therefore it is essential to turn out castings that will embody a minimum of major defects, are of essentially good design consistent with practical conditions, and that will perform satisfactorily in service—these essentials being the definition for a commercially sound casting.[1]

In the development of a satisfactory fabricating procedure, the practice that is under experiment (in use at the time) is altered until a commercially sound casting is produced. The accompanying illustration (Figure 1) shows the results of the perfection of foundry practice in the casting of automobile cylinder heads. The right view of the cylinder head is representative of a definitely inferior and unacceptable casting, because of the presence of defects caused by small shrinkage cavities, commonly referred to as "porosity". These cavities appear as dark specks throughout the center of the head region, the white areas being thick metal in the walls. The left view shows the product of the perfected foundry practice, which was developed after the X-ray was utilized. Between the time of the first (right) and the last (left) radiographs, many exposures were made on pilot castings sent through the production process to develop the practice used. The foundry variables were altered until the defects were either eliminated or maintained within minimum limits, at which time the practice was standardized and routine production commenced. Figure 2 illustrates the accurate determination of two defect in an alluminum casting. The dark areas in the center of the radiograph indicate that the metal is less dense in those places, consequently there must be cavities present, while the light area at the left of the radiograph indicates a more dense metal. The explanation for the light area is that a cavity once existed there, but was filled with a metal of slightly different composition after the removal of the gate in the original casting. The metal which was subsequently poured in did not reach the cavities in the center of the casting, and they appear as shown. The same casting is shown after being sectioned in Figure 3, in which it is difficult to determine the boundaries of the cavity-filler.

Often the use of a monitor casting is combined with radiography of sample castings to determine the depth of defects. A monitor casting is prepared by a tested foundry procedure, after which it is drilled

Fig. 2—Cavities in Sand Castings.

—Courtesy General Electric X-Ray Corporation

1. Earnshaw Cook, "Foundry Appl'ns. Radiography", Symposium in Radiography and X-Ray Diffraction Methods, Am. Soc. Testing Materials, Phila., 1937.

—Courtesy General Electric X-Ray Corporation

Fig. 3—Sections of Casting in Fig. 2

at regular intervals along a straight line in ranging depths to the thickness of the sample casting. The monitor is then subjected to X-rays to form a radiograph of spots corresponding to the projections of the holes along their vertical axes, each spot appearing with a different light density which is proportional to the thickness of the metal remaining under the drilled portion of the hole. If the holes are drilled in regular graduations, a radiograph of this type forms an excellent scale for comparison of depths of defects in the sample casting. The exograph of the monitor is superimposed upon the radiograph of the sample, giving a readable comparison of the depths of the imperfections and the holes, with the operator knowing the depths of the drill holes in the monitor. In this way the analysis of casting defects is effected more readily, eliminating a sectioning operation for the accurate determination of doubtful cases. Similar-appearing defects in the radiograph, such as shrinkage areas and cavities, may be differentiated by the use of the monitor-depth system, with the knowledge of the relative depths of shrinkage-, and cavity-characteristics. By the utilization of control methods the defects may be eliminated from the sample castings subsequently cast.

In Welds

The Bureau of Engineering of the U. S. Navy, the American Society of Mechanical Engineers, the American Petroleum Institute, and countless other commercial producers of welded products have recognized the value of the X-ray as an instrument to disclose injurious defects in welds. In 1931 the Boiler Code Committee of the A.S.M.E. altered its specifications to allow welded construction in Class I boiler drums and unfired pressure vessels, but required complete radiographic inspection of the welded seams for safety. Since 1931 welded construction has progressed rapidly, although it was not used previous to that time because of the nonexistence of a successful and efficient nondestructive test for welds, both in homogeneity and defects. In the construction of the penstocks for the power plant at Boulder Dam fusion-welded construction was utilized, and checked with radiographic inspection. 21.6 miles of seam were welded, and all minutely inspected. This inspection necessitated 77,000 exposures, consuming 1,500,000 square inches of film.[1] Since welding is a much simpler operation than casting, much more of the X-ray examination is devoted to checking and less to perfection of technique.

The process of radiography of welds is the same as that of castings; the weld is subjected to an exposure of X-rays, with defects (slag inclusions, gas holes, cracks, etc.) showing on the film as more- or less-dense areas or spots in contrast to the constant-density of the weld. Figure 4 illustrates gas inclusions in a seam-weld of a 1½-inch plate, an average radiograph of one of the imperfections appearing in many such welds. In addition to defects, the X-ray photograph is an excellent index of the homgeneity of welds.

Crystal Diffraction

Often has the scientist realized the limitations imposed by microscopic examination, for none of the concepts of the composition of matter are borne out by merely reducing the size of the object under inspection. So acute grew the need for peering "beyond the stage of the microscope" that science turned to a better method for information, and found it in the X-ray, originating with von Laue's discovery that crystals diffract the rays. The X-ray, a method to gain knowledge of the interior structure of materials has given the chemist, the physician, and the metallurgist a basis for a wealth of information, and it promises to be the revealing factor in important discoveries in the future. It promises progress to the whole fields of science, and in a particular application to the engineer, it promises progress in the *preparation* and *utilization* of many materials, old and new.

The microscope has been useless in explaining the structure of matter smaller than crystals because of its dependence upon visible light rays for illumination, and consequently any particle of matter smaller than the light ray which attempts to illuminate it is completely invisible. Such a small particle must needs be illuminated by rays shorter than light rays in order to be interpretable by records visible to the human eye or through the microscope. Comparison of the wavelengths of X-rays with those of visible light and other related rays will show their extreme shortness, which

—*Courtesy General Electric X-Ray Corporation*
Fig. 4—Scattered Gas Inclusions, 1¼-inch Plate.

accounts for their penetrability:

Visible	7800-3800 Angstrom Units
Ultra-violet	3800- 100 Angstrom Units
Overlapping Region	100- 10 Angstrom Units
X-rays	10- 0.1 Angstrom Units
Gamma Rays	1-0.01 Angstrom Units

One Angstrom Unit $=10^{-8}$ centimeters.

(Table adapted from Saunders, *A Survey of Physics*—approximate values only.)

It follows that such short rays as those in the X-ray spectrum would be infinitely valuable for the examintion of particles smaller than can be seen by visible light, or by ultra-violet light with filters.

The nature of X-rays is simple—they are a type of radiation similar to visible light, differing essentially in wavelength. They can be produced of various wavelengths upon choice, can be modified and diffracted at will by media for that purpose, only more easily and accurately than visible light rays. They register upon photographic film, upon fluorescent screens, and alter the position of leaves of a charged electroscope, indicating their electromagnetic properties for discharging ionized bodies. Light is transmitted through various types of glass with varying degrees of ease, and similarly X-rays are absorbed by different media with varying degrees of density, i.e., all materials do not possess the same X-ray *transparency*. This fact is the basis for radiography, while the varying diffraction patterns produced on photographic plates are the basis for diffraction analysis.

It is well known that X-rays are produced by the bombardment of matter by rapid-velocity, negatively charged particles (electrons). By the principle of the conversation of energy, a part of the kinetic energy of the rapidly moving electrons is converted into energy of radiation (X-rays), while a great amount is converted into heat energy that is absorbed by the matter bombarded. X-rays of suitable wavelength must be produced for the type of use, whether for diffraction or for radiography; the wavelength being determined principally by the thickness of the article in radiography, and by the type of diffraction used in analysis (Laue, powder, Debye-Scherrer-Hull, Sauter, etc.).

Certain conditions must be fulfilled for the generation of X-rays, these being (1) a source of cathode particles (electrons) directed at a target, (2) a target (anode) located in the path of the cathode particles, and (3) a medium for supplying a difference of potential between the cathode and the anode. The potential difference between the cathode and the anode must be great enough to furnish the required velocity to the electrons emitted to supervene the space between the cathode and the anode such that the necessary X-rays will be produced by the bombardment. The first two conditions are accomplished in the X-ray tube, which may be of two types: (1) an ion (gas) tube, in which the source of electrons is a quantity of rarefied, ionized gas; and (2) a cathode (electron) tube, in which the source of electrons is a heated filament of tungsten. In both tubes the target, (anode) is a small button-like mass of high-atomic weight element, usually of tungsten or platinum because of the high melting point and the efficiency of such an element. The third condition, potential difference, is supplied by a rectified alternating current source, although in pioneer instruments it was furnished by an electrostatic direct current generator or by storage batteries. Coordinated control of these three essential conditions results in the production of the desired X-rays, which are classed according to their characteristic wavelengths, frequencies, and velocities. Figure 5 illustrates the production of X-rays in the Coolidge type (cathode, or electron type) tube X by the bombardment of the anode A by electrons emanating from the filament F. The X-rays themselves are emitted from the tube through the slit S′ in the screen placed between the tub and the diffraction apparatus at the right.

It is known that all substances are composed of small particles of matter which aggregate themselves together and often become visible as crystals under the microscope. Without notable exception all of the physical and chemical properties of a substance depend upon the kind and arrangement of atoms and molecules in the crystal. A prominent example of this fact is the change of ductility, solubility, magnetic properties, and combining qualities of pure iron, and iron-carbon alloys, with the elevation of the temperature of the metal. Knowledge of the kind and arrangement of the atoms and molecules in a given crystal indicates and enables one to predict the physical and chemical properties to be expected from any metal under consideration, whether it be pure, compounded,

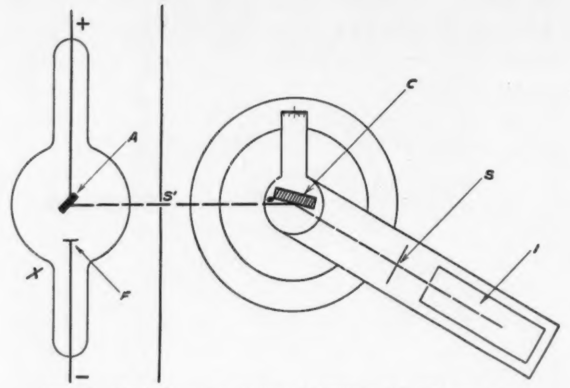


Fig. 5—Coolidge-type Tube and Diffraction Apparatus.

mixed, or alloyed. In the quest of this knowledge the X-ray has been the material medium, furnishing the unknowns by X-ray analysis brought about through the *reflection* of an incident X-ray beam from a plane of atoms within the crystal. The "picture" of these reflected beams upon the photographic film is known as the "X-ray diffraction pattern". In Figure 5 the X-rays produced by the tube pass through the slit S' and fall upon the crystal C (at an angle of incidence, *theta*), in which certain of the X-rays are absorbed and others are reflected from the crystal through the slit S' in the ionization chamber I, where the intensity of the reflected beam is measured. The intensity is then interpreted to give characteristics of the reflected beam and of the reflecting crystal. From Bragg's equation $V\vartheta = 2d \sin\odot$, where d=atomic inter-plane distance and $\odot$=angle of incidence of X-rays, the distance between the planes of reflecting atoms is determined, from which physical and chemical properties of the crystal in question may be predicted in part. A concrete example is that of ductility, which is directly proportional to a function of the interatomic space in the crystal, increasing with the increase in distance between atomic planes.

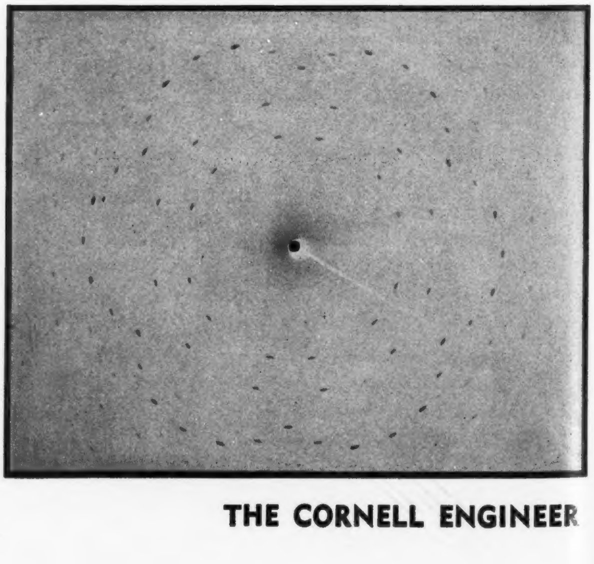
By substituting a photographic film for the ionization chamber, and placing the source of the X-rays, the crystal and the film in a straight line coincident with direction of the X-ray particles, a simple camera is constructed in which a Laue Diffraction Pattern is obtained. The planes in the crystal diffract the X-rays as in the ionization-chamber example, but cause spots on the photographic film as shown in Figure 6, instead of discharging in the chamber. Each spot is the reflection of a certain wavelength from a corresponding crystal plane in one or more orders of depth. The diffraction spots are arranged in the pattern as symmetrical, elliptical shapes having one end of their major axes at the center of the undiffracted spot. All the spots on one ellipse are the result of reflections from planes parallel to a single axis in a single zone, therefore are "zone" reflections. It is seen that the Laue pattern is dependent not only upon the atoms present in the crystal, but also upon the manner in which they are related within the crystal.

Laue patterns are useful for the determination of crystal structure, revealing imperfections caused by interrupted or accidental growth, or by deformation (distortion). This is but one method among many that is used to determine the physical and chemical properties of metals by the metallurgist, the combination of several methods giving the necessary information about new alloys and unknown experimental samples.

So important has the X-ray become to the metallurgist that he finds it in constant application throughout the laboratory and the production line. Generally, it is used in four major fields: (1) determination of the composition and structure of alloys, (2) determination of the effects of rolling and working on the interior structure of metals and alloys, (3) effects of annealing and other thermal treatments on metals, and (4) miscellaneous applications, including measurement of crystal size, uniformity and depth of surface hardening, chemical composition of protective films of oxides, study of crystal structure in electrical properties, and many others. The General Electric X-ray Corporation lists 44 different applications of diffraction apparatus in metallurgy and metallography alone, not counting the applications in chemistry, process industries, mineralogy, physiology, pathology, and biology.

Less than three months after Roentgen discovered the X-ray, practical installation had taken place in the hospital in Vienna, with use in setting fractures and the usual pathological procedures. Such a significant fact cannot be overlooked upon considering the rapid strides X-rays have made since that December day a scant forty-five years ago, and what rapid strides they will make within the next half-century. Certainly the metallurgist, the foundryman, the scientist, doctor, and administrators in other industries will find use for this marvelous tool for peering into the "structure of things" . . . without tearing them apart.

Fig. 6—Lane Pattern with Pinhole Assembly and Flat Cassette.
—Courtesy General Electric X-Ray Corporation



NEWS OF THE ALUMNI

WILLIAM S. BACHMAN '32

William S. Bachman, EE '32, was one of 22 employees of the General Electric Company to receive public citation on February 9 for outstanding accomplishments in 1939. Mr. Bachman is an engineer in the Radio & Television Dept., Bridgeport. The recognition in the form of a citation, certificate, and cash honorarium, was bestowed by the Charles A. Coffin Foundation, established in 1922 to commemorate the initiative, perseverance, courage, and foresight of the General Electric's organizer and first president.

Following is the accomplishment for which Mr. Bachman was given the Coffin Award.

Not matter how good the quality of a radio broadcast may be, certain inherent weaknesses in the design of radio receivers may distort the program at the listener's end. One way to minimize this distortion is through the use of what is known as degeneration. For some time it was impracticable, however, to use the degeneration principle in broadcast receivers because of prohibitive cost and a resulting reduction in sensitivity. Mr. Bachman suggested a connection that makes degeneration effective for tone improvement with strong incoming signals but is less effective, and hence does not handicap the sensitivity, when receiving weak incoming signals. Since its conception his principle, known as the "Tone Monitor," has been used in all but the smallest of G-E receivers, and modifications of it are widely employed in the industry today.

Each year the Foundation selects those members of the General Electric organization who have made outstanding contributions during the course of their work to the progress of General Electric and the electrical art. Since the Foundation was established in 1922, 530 employees have received awards. Significance of honor may be realized when it is considered that the 22 men who received awards this year were chosen from approximately 70,000 persons in the General Electric Company's employ.

At recent regional dinners throughout the country of the American Association of Manufacturers, a group of 100 men were honored by citations as the pioneers of industry in this country in the development, growth, and promulgation of engineering knowledge and practical applications toward the betterment of humanity. Of these 100 men, 27 were Cornellians, of whom 17 attended the Engineering College at this University. These 17 are as follows:

Albert Kingsbury '89 ME, New York City
Frederick B. Downing '95 ME (EE), Penn Grove, N. J.
William E. Woodard '96 ME, New York City
Willis H. Carrier '01 ME, Syracuse, N. Y.
Henry E. Vanderhoef '01 ME, Rochester, N. Y.
Charles B. Dalzell '02 ME, Little Falls, N. Y.
Hannibal C. Ford '03 ME (EE), Long Island City, N. Y.
Thomas W. Rolph '07 ME, Newark, N. J.
Thomas Midgley, Jr., '11 ME, Detroit, Mich.
Harry B. Hull '13 ME, Dayton, Ohio
Alfred L. Boegehold '15 ME, Detroit, Mich.
Laurens Hammond '16 ME, Chicago, Ill.
Louis C. Huck '17 ME, Grosse Point, Mich.
Dudley E. Foster '22 MEE, New York City
James E. Gleason *** Rochester, N. Y.
William H. Mason *** Laurel, Miss.
Samuel M. Langston *** Camden, N. J.
***Did not complete course
Gleason 88-90 M; Mason 96-98 M; Langston 98-01 M

One week following the holding of these several regional dinners a large banquet took place in New York City, at which the nineteen men who were the most distinguished in meritorious service out of the regional 100 were honored. Of these nineteen one was a Cornellian, Mr. Willis H. Carrier, this year President of the Cornell Society of Engineers.

We note in the SAE Journal for February, 1940 that Norman N. Tilley, ME '15, recently resigned his position as chief engineer of the Detroit Plant of Continental Motors Corporation to join the engineering staff of the Lycoming Division of Aviation Manufacturing Corporation. He now heads the Aircraft-Engine Engineering Activity as Vice-President of the Society of Automotive Engineers for 1940.

After graduating in mechanical engineering from Cornell in 1915, Mr. Tilley continued study here until 1918, first as instructor in experimental mechanical engineering, and later as U. S. Army Air Service instructor on aviation engines. He remained in the Air Service until 1920, first as a flying cadet and later as airplane pilot and engineer officer in charge of various training courses at Kelley Field. During the next two years he taught mechanical engineering at the New Mexico A. & M. College and the University of Texas. In 1922 he joined the Engineering Division of the Air Service. He advanced from test engineer to mechan-

(*Continued on page* 16)

ENGINEERING COLL

The CORNELL ENGINEER is proud to present to students and graduates of the College of Engineering the members of the recently re-formed Engineering College Council, which will meet in Ithaca for the first time this month. Selected by President Day from a large group of alumni, these Cornellians are recognized leaders in American industry. In addition to President Day and Dean Hollister, the council includes James W. Parker, J. Carlton Ward Jr., Thomas Midgley Jr., Dr. Harold W. Elley, James C. Wilson, Dr. O. E. Buckley, Alexander W. Dann, Colonel F. W. Scheidenhelm,

Consultant in many hydraulic construction projects, Colonel F. W. Scheidenhelm maintains the council's contact with the field of consulting engineering. Holder of two degrees from Cornell, A.B. in 1905 and C.E. in 1906, he organized and served as chief engineer with several power companies for ten years. Since 1916 he has been partner with Dr. Daniel Webster Mead in a firm of consulting engineers.

Colonel Scheidenhelm has received many awards for his work, including the Fuertes Gold Medal in 1917, and the Rowland Prize in 1918. He was decorated with the Distinguished Service Medal for his service as commander of the 26th Engineers water supply regiment during the first world war. He is a member of the American Society of Civil Engineers, Cornell Society of Engineers, and other professional organizations.

•

Representative of the chemical branch of industry is Dr. Harold V. Elley, director of the organic chemicals department of E. I. duPont de Nemours. Receiving his Ph.D. in chemistry from Cornell in 1916, after gaining two degrees at Nebraska, he became head of the organic division of the duPont organization, and advanced to his present position. Recognized as a leading authority in the field of organic chemistry, he is a member of Sigma Xi, American Institute of Chemical Engineers, and the American Chemical Society.

•

Courtesy Alumni News

Dr. Buckley, who received his Ph.D. at Cornell in 1914 after gaining a BS degree from Grinnell College, needs no introduction to Cornell's educational problems, nor to the requirements of industry. After serving as an instructor here from 1910 to 1914, he became associated with the research department of Western Electric, and subsequently advanced to the position of Director of Research in the Bell Telephone Laboratories. In 1936 he became executive vice-president of the Laboratories, his present position. It was through his efforts that the School of Electrical Engineering obtained the teletype equipment which was recently installed in the Electrical Laboratory.

Dr. Buckley is known in the engineering world for his pioneer work on high speed submarine telegraph cable. A member of many national societies and research organizations, he maintains a vital position in the technical research field, and will provide a valuable key in the correlation of college work to technical requirements.

•

Courtesy Alumni News

James W. Parker has a r... engineering college. In addition ... ing College Council in 1933, he h... member of the Building and Gro... Council, and director of the Corn... University's patents.

Mr. Parker is an authority i... briefly for several companies he t... Edison in 1910. He is now vice-... managed the design and constru... of Sigma Xi and Tau Beta Pi, and... Society of Mechanical Engineers.

•

Thomas Midgley, Jr. ... he graduated as a m... engineer in 1911, has ... name in industry as a ... His most significant con... to the world has been th... tion of Ethyl gasoline, ... discovered in 1923. Aft... ist's work with General... and other companies, he... vice-president of the Eth... line Corporation upon it... tion in 19... Except ... period from 1926 to 192... as a research executive ... eral Motors, he has be... the Ethyl Company eve...

Mr. Midgley has ... many awards for his w... cluding the Nichols M... 1923, the Longstreth m... 1925 and the Perkins m... 1937. The latter award... recognition of his devel... in the production of n... refrigerants. He is also ... ber of Sigma Xi, and Phi ... Phi.

G COLLEGE COUNCIL

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President
les James
dgley Jr.,
E. Buck-
idenhelm,

and Walker L. Cisler.

The purpose of the Engineering College Council is to keep the college in touch with the industrial problems of the present and future. By studying the work of the college and advising the administration and Board of Trustees concerning their problems and policies, the council will keep the program of the school in gear with the type of training required in modern engineering. By adding to available resources and in many other ways the council plans to strengthen the work of the college.

•

Parker has a r itful place on any advisory board named by the
ollege. In addition to serving as chairman of the original Engineer-
ouncil in 1933, he has been trustee of the University for two terms,
e Building and Grounds Committee and the Intercollegiate Athletic
director of the Cornell Research Corporation, which administers the
atents.

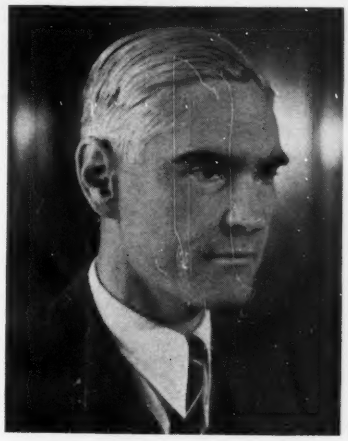
r is an authority in the field of power engineering. After working
eral companies he took a position as boiler room engineer for Detroit
0. He is now vice-president of the company. As chief engineer he
design and construction of many of its projects. He is a member
nd Tau Beta Pi, and in 1938 served as vice-president of the American
chanical Engineers.

•

omas Midgley, Jr., though
raduated as a mechanical
eer in 1911, has made his
in industry as a chemist.
nost significant contribution
e world has been the inven-
of Ethyl gasoline, which he
vered in 1923. After chem-
work with General Motors
ther companies, he became
resident of the Ethyl Gaso-
Corporation upon its forma-
in 19 Ex t for the
from 1926 to 1928, spent
esearch executive for Gen-
Motors, he has been with
thyl Company ever since.

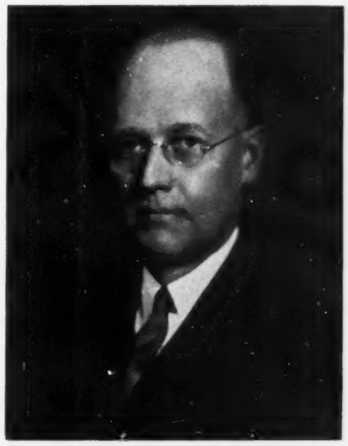
Midgley has received
awards for his work, in-
g the Nichols Medal in
the Longstreth medal in
and the Perkins medal in
The latter award was in
ition of his developments
production of non-tonic
rants. He is also a mem-
Sigma Xi, and Phi Kappa

J. Carlton Ward Jr., an M.E. in the class of 1914, represents the field of precision engineering and the machine tool industry. In his present position as vice-president of United Aircraft Corporation, and General Manager of its Pratt and Whitney Aircraft Division, he is concerned with the precision methods used in manufacturing aircraft engines.



Mr. Ward was works manager of the Pratt and Whitney Division in 1925 when production was begun on the first Wasp engine, using precision machines which he helped build. In 1926 he became vice-president and general manager of the Hartford Machine Screw Company, where he developed a division for the manufacture of small parts used in aircraft engines. He returned to United as assistant to the president, rising to his present position.

•



Mr. J. C. Wilson brings to the council the midwestern outlook on engineering. After graduating from Sibley College in 1906, he was employed by the Fore River Shipbuilding Company of Quincy, Massachusetts, until 1910, when he went to Milwaukee to join the Cutler Hammer Company. Becoming chief engineer in 1919, he has risen to become vice-president and director of the company. Mr. Wilson is a member of Sigma Xi, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. That his interest in Cornell is up to date is evidenced by the fact that he has sent three sons to Cornell, including one still an undergraduate.

•

Walker L. Cisler represents the Cornell Society of Engineers on the Council. Vice-president of the Society in 1937 and president in 1939, he was elected to his place on the council. He holds the position of Assistant General Manager of the Public Service Electric and Gas Company of Newark, New Jersey.

A mechanical engineer in the class of 1922, Cisler was quite active while in college, gaining membership in Tau Beta Pi and Phi Kappa Phi. He is also a member of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

He will coordinate the work of alumni engineers with the needs of the college, and will in other ways represent the Cornell Society of Engineers.

(*Continued on page* 16)

ENGINEERING COUNCIL

Alexander W. Dann now holds the position of executive vice-president of the Dravo Construction Company of Pittsburgh. He assumed this position in 1937, several years after the Dravo Company had taken over the Keystone Sand and Supply Company, of which he was vice-president and treasurer. Mr. Dann's first position, after graduating with a C.E. degree in 1907, was as a junior engineer in the U. S. Army Engineers Corps, serving six years on the Mississippi River Improvement Commission. His long experience with civil engineering construction merits his place on the council.

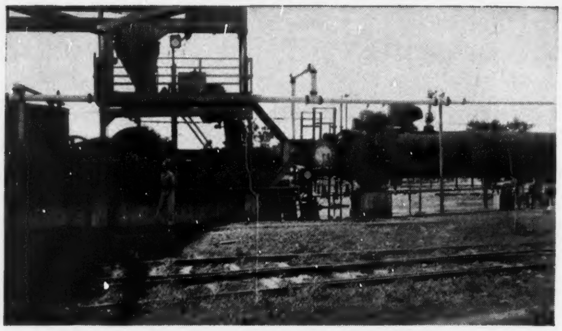
NEWS OF THE ALUMNI

(*Continued from page* 13)

ical engineer, chief engine specification and development unit of powerplant branch, Material Division, U. S. Army Air Corps, at Wright Field, in 1929. In that year he became chief engineer of the Kinner Airplane & Motor Corporation, remaining in that capacity until 1931, when he was placed in charge of engineering with the American Airplane & Engine Corporation, engine department. In 1932 he joined the engineering department of Continental. Mr. Tilley has been active in the SAE committee work since 1930 and has held membership on the Aircraft-Engine Activity Committee; the Aircraft-Engine Division of the Standards Committee, of which he was vice-chairman in 1938 and 1939; the Fuels Subcommittee of the Research Committee; the Cooperative Fuel Research Steering Committee; and the Membership Committee.

A recent invention which has attracted wide interest among technical men is that of the first continuous cellulose pulp digester, developed by Joaquin de la Roza, Sr., M.E. '16. With the de la Roza invention it is now possible to cook cellulose continuously instead of in batches. A more uniform and higher quality of pulp is thus produced at a very much lower cost, not only from wood, but also from sugar cane bagasse, cornstalks, and similar materials which could not be properly digested heretofore. In the digester the material is thoroughly impregnated with cooking chemicals, and forced by a powerful press into a tight plug and into a long rotating cylinder, where after it has been properly cooked with steam, it is discharged as pulp through a series of counter-current high consistency washing presses.

After leaving Cornell, de la Roza was successively Construction Engineer of the new sugar mill at Tuinuc, Cuba; Construction Engineer and Assistant Manager of the new, and at the time, the largest



First Continuous Cellulose Pulp Digester.

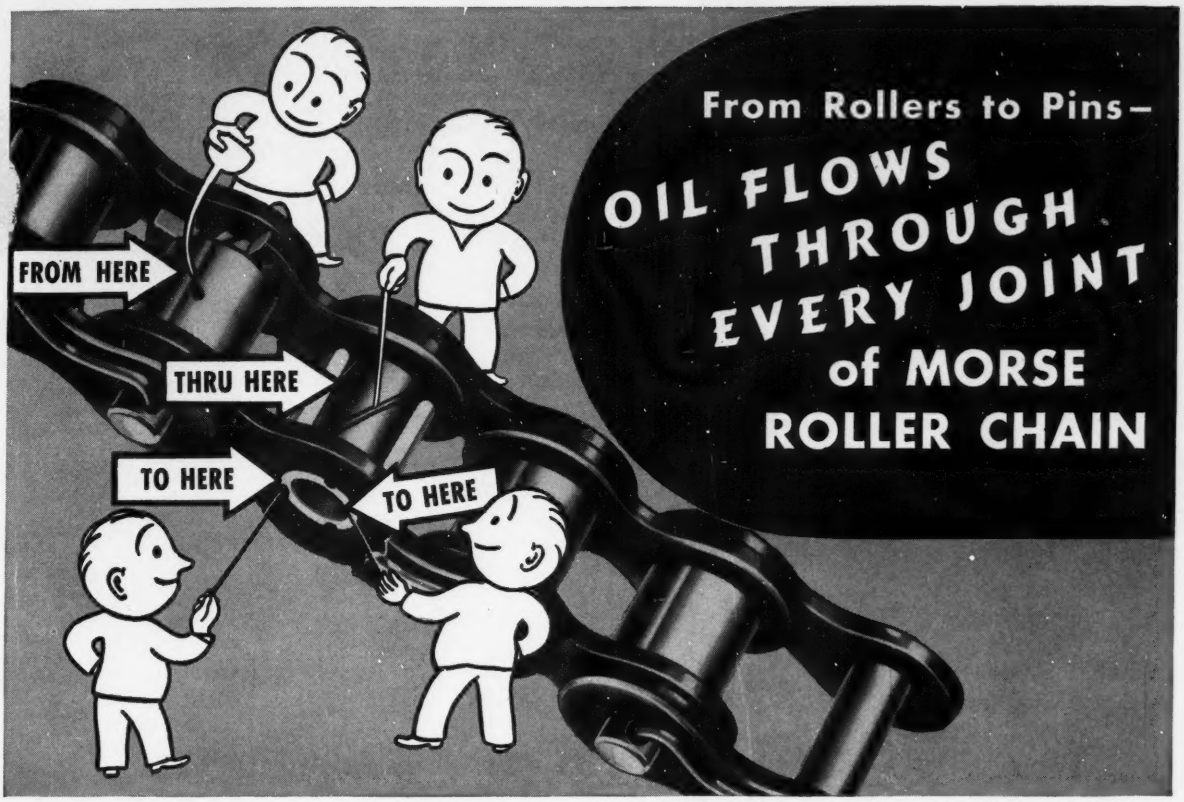
sugar mill in the world at Central Moron, Cuba; and then Technical Director of Czarnikow-Rionda Company of New York. Since 1921 de la Roza has been uninterruptedly engaged in cellulose research and development, and has obtained the basic patents for the production of cellulose from sugar cane, for the continuous digester, and numerous other patents.

In 1925 de la Roza was made President and General Manager of the Bagasse Products Corporation of New York, and in 1926 he also became President and General Manager of its Cuban subsidiary Celulosa Cubana S.A. He resigned from these two companies in 1933 to form his own company, the de la Roza Corporation of Delaware, and lately the de la Roza Continuous Digester Corporation of Cuba. In 1918 de la Rosa married Katharyn Corrigan of Oswego, N. Y., whom he met in summer school in 1913. He has two children, Ellen, fourteen, and Joaquin, Jr., eighteen. The latter is now a first year student in the School of Mechanical Engineering at Cornell. Their home is now at Central Tuinucu, Cuba.

Eugene Murphy M.E., '35, is now half-time graduate and half-time instructor in mechanical engineering at Armour Institute. He is teaching steam power plant and experimental engineering while working toward his Ph.D. His address is 3254 S. Michigan Avenue, Chicago, Illinois.

Charles A. Norris '24, assistant sales manager of the Bakelite Corporation, addressed senior engineers at Cornell University in Room 2 West Sibley at 12 noon on Friday, March 22. His subject was "Plastics".

"Chick" Norris was one of the best known figures on the campus in the years immediately following the World War. He was always in demand as an entertainer with the Musical Clubs, the Savage Club, and other undergraduate organizations. Last June, when he returned to Ithaca with his class for its fifteenth reunion, he presided at the Alumni Rally in Bailey Hall.



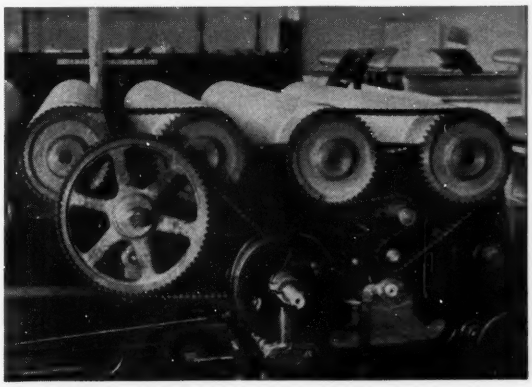
AND IT'S INTERCHANGEABLE!

Now! Morse Roller Chain is interchangeable with every other standard roller chain. And it is so ingeniously designed that it is interchangeable while retaining its exclusive channel lubrication. Now you get the adaptability and convenience of an interchangeable chain with Morse lubricating advantages.

Other impressive advantages of this great chain are the heavier sideplates which give Morse Roller Chain at least the strength of conventional "heavy duty" construction, the rollers ground from solid bar hardened alloy steel stock, the Morse patented spring cotter which will not "chew" or become loosened by vibration.

Morse Roller Chains, channel lubricated and completely interchangeable, will bring to your drives new economies of operation, service, and production. Yet they cost no more than ordinary roller chain drives!

For complete information and a demonstration of the principle of channel lubrication, call in the Morse man in your territory. Or write direct to Morse, Ithaca.



EXTREME FLEXIBILITY OF APPLICATION CHARACTERISTIC OF MORSE ROLLER CHAIN

Complicated drive arrangements are easily handled with Morse Roller Chain. Its unusual flexibility allows its use on drives of long or short centers, slow or relatively high speeds, and in the full range of speed ratios. In multiple widths, this roller chain is particularly suitable for economical operation at high speeds and in close quarters.

Roller chain can operate a number of synchronized drives, and can run on sprockets on either side of the chain.

Morse Roller Chain transmits power with high efficiency, is very easy to install and use, requires little maintenance care, enjoys long, useful, trouble free life.

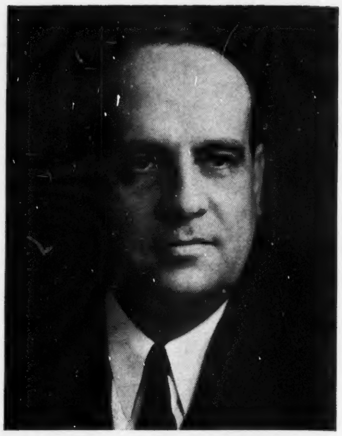
Morse Roller Chains are made in a complete range of sizes, carried up to 100 h. p. in stocks in key cities throughout the country.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO·CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N.Y. DIVISION BORG-WARNER CORP.

Prominent Professors



PROF. WILLIAM C. ANDRAE

To anyone calling upon him in his office, Professor Bill Andrae usually exhibits his extensive collection of pennies. This collection includes every penny that has been issued since 1857 with very few exceptions. He insists, however, that he does not collect them from the standpoint of a Scotchman. In addition to collecting pennies, Professor Andrae has compiled a list of titles of Mark Twain's works which includes 1,200 entries of original titles and cross references. He owns about 35 volumes of this author's books.

Professor Andrae, born in Baltimore, Maryland, attended the Polytechnic Institute of that city; later he received his Bachelor Degree in M.E. from Cornell in 1915 and his Masters degree in 1924. The Robert J. Myers Fellowship having been offered him, he remained at Cornell doing research work and teaching empirical design and kinematics.

In 1917 he was made chief draftsman of the Bureau of Standards. Then followed in close succession his holding of positions as test engineer with the National Aniline Chemical Company. He remembers how his face, colored with various dyes, often looked like a rainbow while he was working with the Chemical Company.

In 1921 he returned to Cornell to take over William Mordoff's position in the Mech Lab. Interspersed with his teaching was work with the Bureau of Standards and the White Motor Company. In 1930 Professor Diederichs and he published a volume on engineering instruments. Just recently he finished the preliminary draft for an ASME Test Code on Power Testing with Dynamometers.

Professor Andrae is officially a professional engineer but has a diversified list of interests other than engineering. He is a member of the Acacia Fraternity, faculty advisor of Alpha Phi Omega Scouting fraternity, a member of the Ithaca District Scout Council, the treasurer of the International Association, and a deacon in one of the local churches.

PROF. W. C. BALLARD

Music hath charms, and it also has its practical side as Prof. W. C. Ballard discovered while an undergraduate at Cornell. For this instance, "those were the good old days," since the chief musician of the University Band, a position held by Prof. Ballard, received free tuition.

When not earning his way through college by creating sound waves on his trombone or baritone, he was busy chasing electrical waves in electrical engineering. In 1910 he received his degree in mechanical engineering with a specialty in electrical engineering since at that time no separate degree in electrical engineering existed. After a few years in the employ of Bell Telephone, he returned to Cornell as an instructor in drawing in East Sibley. He soon transferred to the electrical department in Franklin Hall and today heads the Dept. of Communication Engineering and is Technical Director of Station WESG. He conducts courses in electronics, all the advanced senior communication subjects, and a special course in patents.

In this latter subject, he presents the knowledge and experience gleaned from many years of work concerning problems in which patent cases formed a large part. During the first World War, Prof. Ballard was technical director of the U. S. Army Radio School which was conducted at Cornell. As a designing engineer, he did original work on one of the first radio sets to be installed in airplanes, namely the Navy NC-4's which made the first trans-atlantic flight.

While maintaining a full teaching schedule, Prof. Ballard has acted as consultant for many large radio and electrical companies. Having done pioneering work in talking pictures, he has figured in many patent cases as technical adviser and expert. He has been retained by Fox Movietone and Technicolor in this capacity.

It is of interest to note, that Prof. Ballard is a native Baltimorean and attended Baltimore City College there. At Cornell he has been honored by membership in Sigma Xi, Phi Kappa Phi, Eta Kappa Nu, and AIEE. His avocation is still music and for many years he has been organist at the Presbyterian Church in Ithaca.

News of the College

ELECTED TO TAU BETA PI	
Class of 1940	
Allyn R. Marsh	Eugene S. Thorpe
Charles S. Bowen	Joseph C. Marshall
Class of 1941	
Thomas C. Shreve	N. Travers Nelson
Frederick R. Hillsley	Edmund B. King
John J. Hillsley, Jr.	H. Warner Lansing
Alva E. Kelley	Richard G. Davis
David M. Bradt	J. Robert Meachem
Robert W. Haase	William C. Flickinger
Robert E. Ohaus	Robert S. McCoy
ELECTED TO KAPPA TAU CHI	
Class of 1941	
John T. Riday	Porter W. Gifford
Millard L. Brown	Thomas C. Shreve

Engineers at Cornell take full advantage of the opportunities afforded in extra-curricular activities to broaden their vision by association with students in other colleges of the University, according to a survey based on data recently compiled on the present senior class by the Personnel Office of the College of Engineering. Besides athletics, in which nearly every member of the class participates, student publications, musical organizations, religious groups, general University honor societies, and various types of committees employ the time and energy of many engineers.

Approximately two-thirds of the class belong to fraternities, where they live with men of diverse backgrounds and academic interests. One-sixth are members of musical organizations, such as the Glee Club, band, instrumental club, and Clef Club; and one-eighth are actively interested in religious groups, two being members of the student board of Cornell United Religious Work and others holding memberships in the Newman Club, the Westminster Society, and similar organizations. Three are members of the board of the Cornell Daily Sun, four of the annual, the Cornellian, and one of Areopagus, the campus journal of opinion, in addition to the ten who help to publish The Cornell Engineer.

Four are members of the dramatic club and three of the radio guild; five belong to the Cosmopolitan Club; and eight are members of the Interfraternity Council. Nearly one-fifth of the class have been active on general student committees, with 21 on the Freshman Advisory Committee and others on the committees for the Junior Prom, Spring Day, Junior Smoker, and other traditional campus events.

As might be expected, advanced work in the R.O.T.C. has attracted many engineers. Eighteen are members of the Officers' Club, 21 of Scabbard and Blade, and four of the Pershing Rifles. Other organizations in which engineers are enrolled include the Cornell Outing Club, the Cornell Camera Club, Cercle Francais, the Amateur Radio Club, the Gliding Club, and the Savage Club.

Encouragement to this tendency for engineers to associate with other students in extra-curricular activities is given by the faculty, since it is believed that the successful engineer of the future will need a much broader outlook on life than can be secured by exclusive concentration on technical subjects. There is a parallel tendency to encourage engineers to take as many as possible of their elective courses outside the College of Engineering, thus taking full advantage of the opportunities offered by a large and varied academic program. The results, as reflected in the personalities of seniors, have been praised by employment representatives from many industries.

Since all work and no play is known to make Jack a dull boy, the Engineer staffs gathered together on April 12th to do a bit of celebrating. The occasion was the annual banquet which was held this year at the Victoria Inn. Graced by the presence of Dean Hollister, Director Lewis, Barnard, and Malcolm, Professors Winding and Barnes, Ray Howes, and all boards and compets, the gathering had both its light and serious sides. Bulling with faculty members and reminiscing over the past year's laughs and trials filled a large part of the evening. The chief business of the meeting was the announcement of the new boards for the coming year. Heading these will be Robert C. Ross, A.E. '41, Editor-in-Chief, and David M. Bradt, M.E. '41, Business Manager.

Expressing appreciation for the spirit of cooperation shown by the members, Beach Barrett bade official farewell for the seniors in wishing continued success for the incoming boards.

Guest speaker was Director Lewis of the School of Electrical Engineering. He stressed the importance of the Cornell Engineer as the binding link between alumni and students, especially in the future when universities will have to depend on concerted support from all alumni instead of from a few generous contributors. In such circumstances the student magazine serves to keep the alumni in touch with the work that is being done at the university and helps maintain their interest in their Alma Mater.

Interest in aeronautics has increased among students at Cornell University during the past few months. Six seniors are registered for the Aeronautical Engin-

(*Continued on page* 28)

CORNELL SOCIETY *of* ENGINEERS

WILLIS H. CARRIER '01, President
Carrier Corporation, Syracuse, N. Y.

JOHN P. SYME '26, Vice-President
(New York Regional), New York, N. Y.

HENRY B. BREWSTER '98, Vice-President
(Syracuse Regional) Syracuse, N. Y.

PAUL O. REYNEAU '13, Secretary-Treasurer
107 East 48th Street, New York, N. Y.

FURMAN SOUTH, JR., '12, Vice-President
(Pittsburgh Regional), Pittsburgh. Pa.

HOWARD H. INGERSOLL '15, Vice-President
(Philadelphia Regional) Philadelphia, Pa.

HERBERT B. REYNOLDS '11, Recording Secretary
New York, N. Y.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Message

Fellow Engineers:

One of the principal objectives of this Society, as expressed in the preamble of its constitution quoted above, is "to promote the welfare of the College of Engineering at Cornell University." As a step in putting this purpose into practical effect, I am glad to announce that the Engineering College Council has invited the Cornell Society of Engineers to select one of its members to serve on this body. As President of this Society, I am pleased to announce the choice of Mr. Walker L. Cisler of Newark, New Jersey, Past President of this Society and a member of our Executive Committee, to represent us. This is an ideal appointment because Mr. Cisler has always taken an active interest both in the affairs of this Society and of the Engineering College at Cornell. We feel certain that his active cooperation in the Council will be of benefit to the Engineering College.

I am happy to announce a substantial increase in the membership of our Society during this year. For this we have to thank Mr. George N. Brown, Chairman of the Membership Committee. This year we have also carried out the policy previously established of forming regional groups of this Society in industrial centers. The first section formed was that of Pittsburgh in 1938. This year we have added a section in Philadelphia and another in Syracuse. The Chairmen of these regional groups automatically become Vice Presidents of this Society.

PITTSBURGH SECTION

Mr. Furman South, Jr., Chairman
Lava Crucible Company of Pittsburgh
Wabash Building, Pittsburgh, Pa.

The Pittsburgh section announces that it will have a meeting about May 1st where they intend to have exhibits of various industries in the Pittsburgh district with a roster of the Cornell engineers connected with each.

PHILADELPHIA SECTION

Mr. H. H. Ingersoll, Chairman
260 South Broad St., Philadelphia, Pa.
Mr. Edwin H. Brown, Secretary
2930 Belmont Avenue, Ardmore, Pa.

On December 7, 1939, at the time of the meeting of the American Society of Mechanical Engineers in Philadelphia, a luncheon meeting of the Cornell Society of Engineers was held at the Engineers Club of Philadelphia at which the organization meeting of this regional group took place. The speakers were:

Dean S. C. Hollister of the College of Engineering.
Prof. J. R. Bangs, Jr., '21
Willis H. Carrier, '01
Walker L. Cisler, '22

Another luncheon meeting of this section was held on Wednesday, March 20th.

SYRACUSE SECTION

Mr. Henry B. Brewster, Chairman
628 James Street, Syracuse, N. Y.
Mr. C. Travis Brown, Secy.-Treas.
L. C. Smith & Corona Typewriters, Inc.
701 E. Washington St., Syracuse, N. Y.

The organization meeting of the Syracuse section was held on Tuesday evening, January 23rd, 1940 at the University Club of Syracuse. Prof. John R. Bangs, Jr., was the principal speaker.

The first meeting following the organization meeting was held on Friday evening, March 8th, 1940 at which our distinguished Cornell alumnus, Mr. Thomas Midgley, Jr., inventor of the base for Ethyl gasoline and of modern refrigerants, was guest speaker. His subject was "The Social Aspects of Modern Engineering."

The next section meeting is scheduled to take place in April and will be held jointly with the Cornell Club of Syracuse. President Day will be guest speaker under the auspices of the local section of the Cornell Society of Engineers.

Future local section meetings will include talks by Cornell Engineering Alumni on engineering subjects of interest to all branches of the profession.

It is hoped that additional regional groups may be formed during the coming year. Your Executive Committee hopes that the broadening of these activities through the formation of these regional groups will increase the membership and promote the aims of the Society.

Very truly yours,
WILLIS H. CARRIER,
President.

RIGHT OR WRONG?

A 2-minute test for telephone users

1. It's impossible for you to telephone to people in two different cities at the same time.

RIGHT ☐ WRONG ☐

2. Police Radio Telephone made by Western Electric is an outgrowth of research at Bell Telephone Laboratories.

RIGHT ☐ WRONG ☐

3. About 75% of the Bell System's 85 million miles of telephone wire is contained in cable.

RIGHT ☐ WRONG ☐

4. Lowest telephone rates to most out-of-town points are available every night after 7 P. M. and all day Sunday.

RIGHT ☐ WRONG ☐

ANSWERS:

1. *Wrong.* Telephone Conference Service enables you to talk simultaneously with as many as five other people.

•

2. *Right.* And that's true also of broadcasting equipment, aviation radio telephone and marine radio telephone.

•

3. *Wrong.* Over 95% is now protected by cable — nearly ⅔ of which is underground.

•

4. *Right.* Why not telephone home oftener? Your family will enjoy it—so will you!

AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES — BELL SYSTEM

BELL TELEPHONE SYSTEM

BEACH BARRETT, M.E. '40

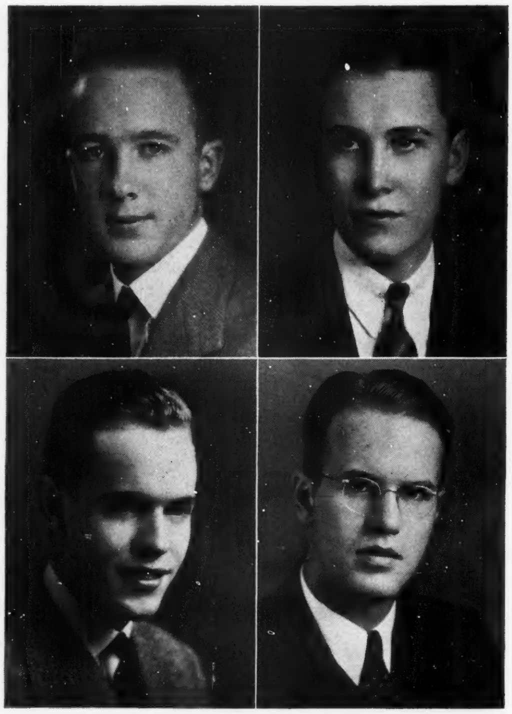
And then there's the engineer who gets extremely annoyed when an Arts student deplores the uncultured existence of the engineer. There are many engineers who react in the same way towards this stimulus, but Beach Barrett's verbal reaction is exceptionally interesting, as his room-mate will testify. Incidentally, his room-partner is an Arts student.

When the new editor-in-chief of the CORNELL ENGINEER takes over room 40 of Lincoln Hall, he will step into a neat and efficient office, thanks to the untiring efforts of the former editor, Beach Barrett. Many are the times that Beach has walked into the office, taken a good look at the situation, thrown off his coat, and then picked up the broom with a sadistic look in his eyes.

But Beach will never become a janitor, for he has already shown the makings of a great engineer. His four years of invested time have yielded some excellent profits, both scholastically and extracurricularly. Four years of study have resulted in election to Tau Beta Pi and Phi Kappa Phi, to say nothing of

(*Continued on page* 26)

The Cornell Engineer presents



Roland E. Graham, Jr., C.E. '40

Summers spent between college years are not always remembered by many, but Roland has spent two summers that he may remember for some time to come. Between his sophomore and junior years he went to surveying camp. There, he not only learned a great deal about surveying but made many new friends. He spent the following summer at the United States R.O.T.C. Ordnance Camp. There, he had the experiences of firing large-caliber field guns and riding in Army tanks. If one wishes to enjoy himself and make new acquaintances, Roland advises no better place than a summer camp.

Roland's father was a Cornell graduate, a fact which no doubt had a great deal to do with his decision to come to Cornell. During his four years here he has had several responsible positions. He is house manager of his fraternity, Theta Xi, and business manager of the Cornell Dramatic Club. He has also served very capably as advertising manager of the CORNELL ENGINEER.

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ARTHUR W. HARRINGTON, E.E. '40

If a man's smoking habits are a clue to his personality, we've got a line on Arthur W. Harrington. Art, a veteran pipe smoker, has the calm, deliberate manner possessed only by a man with a collection of thirty pipes.

Art started off his extra-curricular activities by going out for THE CORNELL ENGINEER in his sophomore year, and has distinguished himself by becoming circulation manager of the ENGINEER in his senior year.

He is a first lieutenant in the Cornell R.O.T.C. Signal Corps, and recalls an eventful summer at the Fort Monmoth R.O.T.C. camp where he had an attack of appendicitis and spent his last three weeks of camp in the hospital.

Realizing that the reflections from the glass on their slide rules are often the only glimpse many engineers get of what is going on around them, Art has joined the Book of the Month Club, and enjoys his leisure reading very much.

This spring will find Art a very busy man getting the electrical engineering exhibits for the Cornell Day show

(*Continued on page* 26)

Joseph C. Marshall, E.E. '40

Surveying, computing and sounding with the Army Engineers—that's the way Joseph C. Marshall spent his past two summers. Some of his work was done inside, pouring over charts and maps; some was done outside, making contour maps of ocean beds and assisting in the construction of two jetties, near Barnegat Bay, New Jersey. Working with the Army Engineers was no easy task, for Joe had to be out in all kinds of weather making observations. With a job as difficult as this, he did not have too much time for sport and relaxation, but he managed to get in some boating—one of his favorite sports. With four of his friends, he bought a motor launch which any of us might envy. Joe, however, insisted upon calling it a "barge" and told of piloting her amidst the snootiest yachts in the bay near Atlantic City. Occasionally, when not working, they would take a short trip down to Cape May.

This interest in boating dates from the time that Joe was a member of the freshman crew squad. He speaks with great enthusiasm of rowing back to the

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Machine Tools And The Emergency

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asks somewhat more freedom than has recently been allowed by the government with respect to depreciation policies and the plowing back of earnings into plant and equipment. The machine tool industry believes itself competent to meet whatever demands may be made upon its facilities and its ingenuity—provided it is permitted to work out the problems arising from its particular situation in conformity with methods and procedures which past business experience has shown to be prudent and reasonable.

In short—the industry is both willing and ready to meet any sudden emergency demand, provided it may be permitted to pay for emergency expenditures out of emergency income. This could be accomplished by permitting two things—first, a depreciation write-off more rapid than is now customarily allowed, and second, a re-investment of earnings without penalty taxes.

With research and development proceeding as rapidly as is today the case, the useful life of equipment grows shorter. In other words, equipment depreciates, or becomes obsolete, more rapidly. A company's "depreciation allowance" consists of that portion of its earnings which the government allows it to offset against depreciation by wear and obsolescence without the necessity for paying taxes thereon. Of these, obsolescence is by far the more important on productive equipment. If such allowances were set in proportion to the demonstrated economic life of a given piece of equipment in relation to the work on which it is used, it would immensely simplify the problems machine tool builders face today. With the demand for immediate production expansion without assurance that such demand may continue, a flexible depreciation allowance based on actual experience would permit them to recover their investment costs in new equipment and in enlarged plants more rapidly than is at present the case.

Similarly, a relaxing of the current governmental attitude toward re-investment of earnings in plant and equipment would help to lessen the risks of expansion. As things stand today, a company investing a large share of its earnings in additional machines of facilities may be faced with a heavy tax by reason of the division of earnings from dividends to re-investment. A company may therefore be quite hesitant about increasing its facilities to meet an emergency peak demand, because of its finances such increased facilities out of earnings, it may be heavily taxed; while if it finances such increases out of borrowed money, the period of high demand may swiftly pass, leaving the company with its added facilities both idle and unpaid for.

In the sense that today's situation has brought to American machine tool industry the largest sudden demand in its entire history, the present picture is in

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The Cornell Engineer

EDITORIAL

Once again a Senior Board retires and a new Board steps into its place. Now is the appropriate time to review the accomplishments of the retiring Senior Board. First of all, the Cornell Engineer has been run at a profit during the past year, none of it claimed by the Seniors but all left with the magazine. The issues for the last year were all published on or before the first of the month in contrast to years before. The practice of writing editorials was revived and during the course of a year, much expert advice was offered to the student by the former editor, who was well qualified to offer such advice.

During the past year the standard of the magazine has been raised. The articles have been chosen more carefully and better illustrated. The write-ups of all personalities and news have been better and the make-up of the magazine as a whole has been improved. Lastly, the training of the staffs under the Senior Board has been better than ever, so that we who come after them are better able to take over. It is fitting that we should feature these men in the Personality write-ups so that the reader might get a look at those who have been behind the scenes for the past year. Notice that all of them have been active outside of the Cornell Engineer.

As was said in the editorial of the March issue, organization cannot be stable. Either it moves forward or it moves backward, and we intend to move forward. First we intend to take up where the outgoing Senior Board left off and continue their work on the five points mentioned. In addition we are going to better the office efficiency. The issues are going to be mailed out quicker and more efficiently. Correspondence is to be more prompt and more courteous. Records are to be kept on possible articles and past staff assignments to insure that each man rotates and learns each job. Each man is to have more experience in the work by doing more work.

We are looking forward to a year of experience, comradeship, fun, and work. To have it said at the end of our year that the Cornell Engineer has improved is all the reward we can ask.

BEACH BARRETT, M.E. '40

(*Continued from page 22*)

the appearance of his name on the Dean's List for the past four years. But, as Beach maintains, studies are not the only phase of college life which are important to the full development of the individual. His contention has developed into somewhat of a catalogue of activities on the engineering campus. Honors and societies include: Chairman of A.S.M.E.; Scabbard and Blade; Officers Club; and Secretary of Sphinx Head. As a member of the Deke House he has been Rushing Chairman, President, and representative on the Interfraternity Council. Other activities include: Freshman Advisory Committee; Spring Day Committee; Cadet Lieutenant Colonel, R.O.T.C.; Engineering Show Committee; and Editor-in-Chief of the CORNELL ENGINEER. Long ago, when Beach was a sub-frosh, he came up to take a look at the Cornell Engineering Show. This year, he will be responsible for seeing to it that others will be wanting to do the same thing. He is the Publicity Chairman of the Show.

Vacations were designed for rest, and Beach has definitely been convinced of the wisdom of this design. He has spent his summers guiding an outboard motor boat across the salty waters of Peconic Bay, Long Island.

When Beach leaves Cornell, he plans to enter production work, a field which has always held his interest. We who have worked with him know that he will achieve only the best in this field, one in which ability, personality, and cooperation are commensurate requirements.

ARTHUR W. HARRINGTON, E.E. '40

(*Continued from page 22*)

rounded up. He is in charge of all of these exhibits and promises some good ones for this year's show.

In looking over the records, we find Art is in the first quarter of his class, is a member of the A.I.E.E., and is treasurer of the electrical engineering honor society, Eta Kappa Nu.

Art became interested in electrical engineering through tinkering with radios in high school. He still likes to play with them, and finds time to repair those belonging to other members of his fraternity, Sigma Nu. He picked his senior option of power as a result of his summer experiences with a utility company in Montreal. The biggest thing he worked on was the repair of a 22,000 kva turbo-generator. This was a two-month job in itself, and gave Art some real experience.

Art will begin working at the Philadelphia Electric Company when he graduates next June. This job is quite important to him for, you see, he is practically a married man and, after the girl, a job is the next most essential thing. The lucky woman is not a co-ed, but a home town girl, to whom Art has been engaged for a year.

ROLAND R. GRAHAM, JR., C.E. '40

(*Continued from page 22*)

Numerous activities have not kept him from maintaining a high scholastic average, however, for he holds a John McMullen Regional Scholarship. He has also been honored by being elected to Chi Epsilon and Tau Beta Pi.

Any free time that he has left, Roland easily fills by reading good books or furthering his excellent United States stamp collection.

Design and construction work hold the most interest for him, and after graduation Roland expects to work with a large eastern steel company in this field.

JOSEPH C. MARSHALL, E.E. '40

(*Continued from page 22*)

boathouse and to a hearty meal "as the sun fades far away in the crimson of the west." But boating is not the only sport in which Joe is interested. He likes ice-skating too, and he has played football on his house team.

Scholastically, Joe stands near the top of his class. He is a member of Tau Beta Pi and Eta Kappa Nu, the electrical engineering society, as well as a member of the Delta Club and the Radio Guild. He represented the AIEE, of which he was the Secretary-Treasurer, at the convention in Springfield, Massachusetts this past winter. Joe has served as House Manager and Rushing Chairman, and he has recently been elected Treasurer of his social fraternity, Kappa Sigma.

During the summer of his freshman year Joe was social director and life-guard at a resort hotel in the Pocono Mountains. "The ease I acquired in meeting all types of people under various conditions," he says, "certainly has proved valuable."

Machine Tools And The Emergency

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fact an emergency. But if granted the freedom of action, with respect to depreciation schedules and reinvestment of earnings, which would seem only reasonable and proper under the circumstances, the industry feels competent to accept today's situation as merely another challenge to its ingenuity and its capacity for swift and decisive progress.

It is convinced that the solution to the present machine tool dilemna—if indeed it is a dilemna—lies along the lines of individual initiative, freedom of competition, research, development, and the plowing back of earnings into equipment, plants and futures—the same means and methods which have always been the backbone of the progress of American industry.

COLLEGE NEWS

(*Continued from page* 19)

eering Option in the Sibley School of Mechanical Engineering, and 15 juniors in the School are taking the elective course in aerodynamics. Five special courses—areodynamics, automotive power, internal combustion engines, and airplane design recitations and computations—together with other courses in mechanical engineering, constitute the aeronautical engineering option for the B.M.E. degree.

In cooperation with the Ithaca Airport, the College of Engineering has undertaken a Civilian Pilot Training Program, with 45 students in the ground school at the University, of whom 40 are taking actual flight training.

A variable-pitch airplane propeller, a cylinder assembly for an airplane engine, and other parts suitable for demonstration purposes have been donated to the College of Engineering by Pratt and Whitney Aircraft. The material is in use in connection with this training program for pilots.

These additions to the equipment of the College were received through the efforts of J. Carlton Ward, Jr., a graduate in the Class of 1914 who is general manager of the company. He is also a member of the Engineering Council of the College of Engineering at Cornell.

At the regular meeting of the A.S.M.E. on March 5, M. J. Galdo, '41, ME, spoke on "Cane Sugar Production in Cuba." Mr. Galdo's family owns a sugar mill in Cuba so he was well qualified to speak on the subject. The talk was illustrated by slides of scenes in various mills. At the meeting on March 5, Mr. A. R. Stevenson, Jr., Staff Assistant to vice president in charge of engineering spoke on "The Development of a New Product". Mr. Stevenson is in charge of the G.E. training course and a well known speaker.

Coming up on the A.S.M.E.'s calendar, April 9 is a speaking contest open to the members; April 16, "A History of Automobiles," by P. M. Heldt; April 20, an inspection trip to the Corning Glass factory; April 23, "The Manufacture of Glass Tubing," by J. P. Dods.

The annual CORNELL ENGINEER-faculty beer party and smoker was held February 23 in the Psi Upsilon house. This was the second such occasion, and it met with even more success than the first. All schools of the College of Engineering were represented among the faculty. The department of Experimental Engineering was especially well represented. Informal discussion was augmented by motion pictures taken in the various laboratories and classrooms of the college.

Preparations for the Fuertes Memorial Contest in Public Speaking were begun at Cornell last month with the appointment of a faculty committee representing the College of Architecture and the four schools of the College of Engineering. The committee includes Professor M. G. Northrop, chairman, and Professors J. A. Hartell, C. C. Winding, W. H. Hook, and E. W. Shoder.

The contest is open to juniors and seniors in engineering and architecture and offers prizes of $80, $40, and $20 for original speeches on technical subjects. Preliminary tryouts will be held soon, at which contestants will present letters outlining their proposed speeches and deliver five-minute speeches before a group of judges. Judges for this tryout will be Professors A. H. Detwelier, M. G. Malti, C. W. Mason, H. J. Loberg, and E. N. Burrows.

The final contest will be held on April 19.

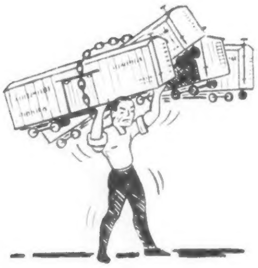
The president of a company that specializes in roofing tells about a tin roof of a Kansas store that was torn off and rolled into a compact bundle by a cyclone. Having a sense of humor the owner wrapped a few strands of bailing wire around the ruin and shipped it to Henry Ford. In due time came a communication saying:

"It will cost you $48.50 to have your car repaired. For heavens sake, tell us what you hit!"

—*Missouri Shamrock*

Confucius say: man who listens to motor knocks make good engine-ear.

G-E Campus News



4400 TIMES HIS OWN WEIGHT

A MAN could lift four 100-ton freight cars if he were proportionately as strong as a new Alnico magnet assembly recently developed in the General Electric Research Laboratory.

The greatly increased strength of the new magnet is due to a special mounting, which permits the magnetic flux to pass through many air gaps instead of the usual two in bridging from pole to pole. This makes possible a more efficient utilization of the magnetic energy. In recent laboratory tests a magnet weighing only one quarter of an ounce was able to support 69 pounds—about 4400 times its own weight. This new development, although not yet commercially available, broadens the field of permanent magnet applications.

TWO OUT OF TWENTY

IN his selection of the 20 outstanding men and women of 1939, Durward Howes, editor of "America's Young Men," honored two General Electric leaders: Philip D. Reed and Katharine B. Blodgett.

Mr. Reed has been with General Electric since 1926. H received his engineering degree from Wisconsin in 1921 an his law degree from Fordham University three years lat In 1937 he became the assistant of Gerard Swope, Presid of General Electric. Mr. Reed is now Chairman of the Boa of Directors.

Miss Blodgett was graduated from Bryn Mawr in 191 received her M.S. degree from the University of Chica , and spent the next six years in the General Electric Researc Laboratory in Schenectady. In 1924 and 1925 Dr. Blodgett studied at the Cavendish Laboratory in Cambridge, England, where she received the degree of Doctor of Philosophy. Returning to the G-E Research Laboratory, she has since been engaged in the study of molecular films.

2,000,000 HORSES

EVEN in its heyday the Wild West would hardly have tried stopping a stampede of 2,000,000 horses. Yet the job of stopping 2,000,000 horsepower of electric energy has been assigned to the General Electric breakers installed at Boulder Dam, and they do the job in 1/20 of a second. And the relays which trip these breakers are even more versatil for it takes them only 1/200 of a second to locate trouble an trip the proper breaker.

The power developed at Boulder Dam is carried to Lo Angeles at 287,000 volts—the highest voltage in the wo in regular service. Two transmission lines, running side b side, are used to span the 38 miles. To protect these lin required the development of circuit breakers capable of inte rupting one and a half million kilowatts of power.

Student engineers, recent college graduates taking the G Test Course, had the responsibility of testing these circ breakers in the Philadelphia Works of General Elect

GENERAL ELECTRIC

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